AD-A146 652 TWO PROGRAMS FOR THE HP9836C COMPUTER TO ACQUIRE FREQUENCY OR VOLTAGE DATA FROM A SOURCE(U) NAVAL OCEAN SYSTEMS CENTER SAN DIEGO CA M R PAULSON SEP 84 1/1

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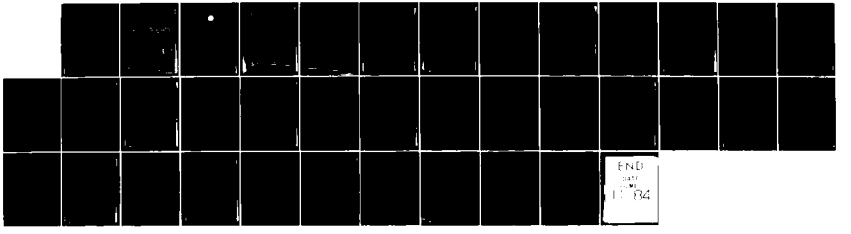

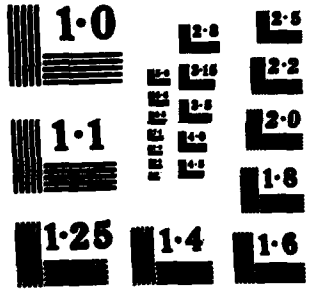
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Technical Document 738

TWO PROGRAMS FOR THE HP9836C COMPUTER TO ACQUIRE FREQUENCY OR VOLTAGE DATA FROM A SOURCE

M. R. Paulson
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September 1984
Final Report

Prepared for
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Approved for public release; distribution unlimited.

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TWO PROGRAMS FOR THE HP9836C COMPUTER TO ACQUIRE FREQUENCY OR VOLTAGE DATA FROM A SOURCE

M. R. Paulson

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Two programs written in Basic for the HP9836C computer are described. While the two programs are similar, the first reads frequency, plots it, and stores it on the disk; the second employs the interrupt technique, providing versatility.

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ILLUSTRATIONS

OBJECTIVE

The objective of this work was to provide a computer program for the HP9836C which could read frequency data from the HP5345A Frequency Counter and plot these data on the computer screen, with the option of dumping the plots to the line printer. The data were also to be recorded on disk for further processing. While frequency was of primary interest here, the program should be useful for other types of data, such as phase locked loop error voltage or amplitude readings.

INTRODUCTION

Two programs have been written for the HP9836C computer in Basic to obtain frequency data from the HP5345A frequency counter. While the two programs are quite similar, the first one reads frequency, plots it, and stores it on the disk. The main difference in the second program is that it uses the interrupt technique, so that between frequency measurements it can do other things. The first program is listed in Appendix A and the second in Appendix B.

FIRST PROGRAM

DESCRIPTION

Since the two programs are quite similar, only the first one will be described in detail. The original program was written by R. L. Kellogg, but many changes and additions have since been made. It is probable that further improvements could be made to the program, but as it is it does a satisfactory job.

This program calculates frequency offset values from a "center frequency" identified in the program as C-band. This frequency, as seen in the program, is 100 kHz. Before running the program, it will have to be changed to the center frequency of whatever signal is of interest. The program then multiplies this offset frequency by 10 and converts it to INTEGER form before storing it. This has the advantage of allowing much more data to be stored on a single disk and at the same time provide a tenth Hertz frequency resolution. When the frequency is read from the disk it is divided by 10 before it is used. The disadvantage is that it limits useful frequency offset measurements to between +3276 Hz and -3276 Hz. Normally, if the frequency value is outside these limits, the computer quits and outputs the message that INTEGER limits have been exceeded. To avoid the problem of the computer quitting, if any value is outside the limit, it is set to the limit and that value stored. It is possible to store larger frequency offsets, with a corresponding reduction in frequency resolution, by changing the value of the constant, D-resl. Presently, it is set to 10 in the program. If it were changed to 1, frequency offsets between +32767 and -32767 could be recorded. In this case, the frequency resolution would be 1 Hertz.

The time of the frequency measurement is determined with the use of the computer's internal clock. This clock is read, to the nearest second, at the

beginning of each 256-sample data record and this value is subtracted from the time for subsequent measurements in the record. This value is then converted to INTEGER. After 256 frequency samples have been taken, the time array is added to the frequency array and stored as a 1024-byte record in the data file. The starting time for the record is stored in a corresponding record as a REAL number in a separate file. When the data are read from the disk, the process is reversed.

According to Kellogg, this method should allow about 18 hours of frequency measurements to be stored on a disk if measurements are made at 1-second intervals.

RUNNING THE PROGRAM

Before running the program, make sure that the address of the frequency counter is set to 12 (that is, A3 and A4 are set to 1 and A2 and A5 are set to 0). Also, make sure that the switch marked TALK ONLY and ADDRESSABLE is in the ADDRESSABLE position. These switches are located on the back of the frequency counter.

After the program is loaded and RUN is pressed, the computer asks for the scale desired for the plot that will be displayed on the screen. These four values are input at one time, separated by commas. The first value, called MAX. TIME, is the length of the time display on the horizontal axis. The second value is either an M or an H, depending on whether the first value is in minutes or in hours. The third and fourth values are the minimum and the maximum frequency, in Hertz, to be displayed on the vertical axis.

This program makes extensive use of what are referred to as soft keys. These are the keys in the upper left of the keyboard, labeled K0 through K9. The function of these keys can be changed by the program. At any given point in the program, the key function is shown in a corresponding box at the bottom of the screen. However, these keys are enabled only while the program is running.

Once the scale of the data plot has been entered, the computer comes up with the display DATA ACQUISITION and K0 shows COLLECT DATA, while K4 shows REVIEW DISK. If one wishes to collect data, K0 is pressed; if data have already been recorded on a disk and one wishes to see a plot of the data, the disk is put in the left drive and K4 is pressed.

DATA ACQUISITION

Assume that K0 has been pressed. The next thing displayed is

REAL-TIME COLLECTION
PUT DATA DISK IN LEFT DRIVE
INITIALIZE DISK IF REQUIRED

and K0 now reads CONT. PROGRAM and K4 reads INIT. DISK. Put a disk in the left drive, and if it has not been INITIALIZED, press K4; otherwise, press K0.

If K4 is pressed, the disk will be initialized. Once that is complete, press K0 to continue the program. The next thing displayed is

ready to collect

while K0 reads START COLLECT, K1 reads G-DUMP ON/OFF, K2 reads CHG. SCALE, and K4 reads STOP COLLECT. K0 is pressed to start the data collection.

The scale of the plot on the screen can be changed at any time while the program is running by pressing K2. The screen then displays

scale time/freq axes
Enter Screen Width Time (Minutes/Hours), (M/H)

A new time scale is entered, followed by a comma and an M or an H to indicate whether it is minutes or hours. The display then shows

Enter Screen Height Fmin., Fmax. (Hz)

The graph is then re-drawn and plotting continues with the new scale. Data that were plotted on the old graph will not be shown; however, they will be stored on the disk. One point should be emphasized: during the time that the computer is waiting for input (e.g., for the new scale values), the frequency counter is not read and no data are obtained.

To terminate the data collection, K4, labeled STOP COLLECT, is pressed.

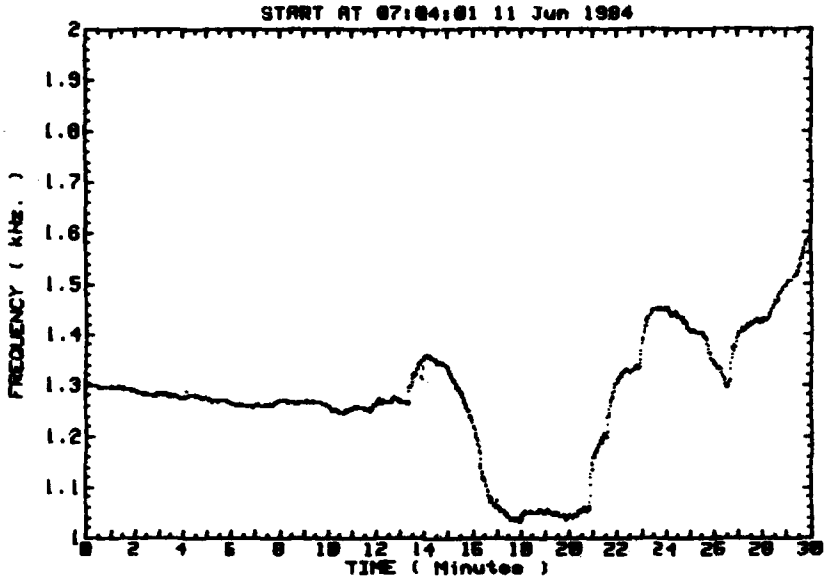
REVIEW PLOT DISK

If K4, labeled REVIEW DISK, was pressed, the computer will plot the data in a manner similar to what it does for the real time data, except it gets it from the disk. In this case, K0 now reads START PLOT, K1 reads G-DUMP Y/N, K2 reads CHG. SCALE, and K4 reads STOP PLOT. Here, K2 works the same way as has already been described. K4 terminates the plotting.

COPYING SCREEN PLOTS ON THE PRINTER

It is possible to copy, or dump, the screen plots to the HP2671G Printer. (The G indicates graphics capability.) Key 1 has been set up with an on/off toggle capability. The default condition is off. Push it once and it is on; push it again and it is off. The status of the key is displayed in the lower left corner of the screen during both data acquisition and disk plotting. When the dump routine is off, the computer plots across the graph until the right limit is reached; then the graph is erased and a new one started with the starting time equal to the ending time of the previous plot. This is repeated continuously as long as data are taken or disk data plotted.

When key 1 is in the ON position the same thing happens, but before starting a new graph on the screen when the plot reaches the right edge, the computer outputs, or dumps, the plot to the printer. Two sizes of plot are possible: the standard size shown in figure 1, and a double size plot shown in figure 2. To get the larger size plot, type DUMP DEVICE IS 701, EXPANDED



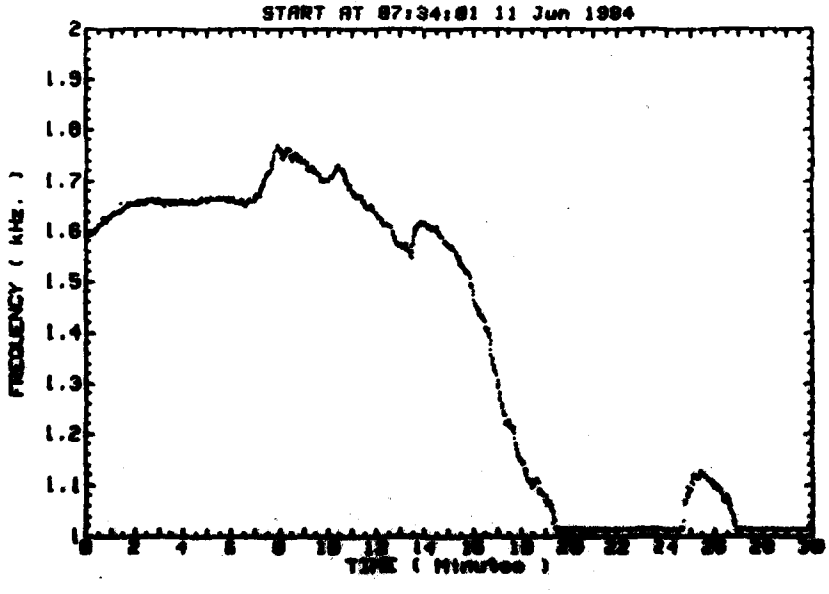


Figure 1. Examples of frequency versus time plots, small graph.

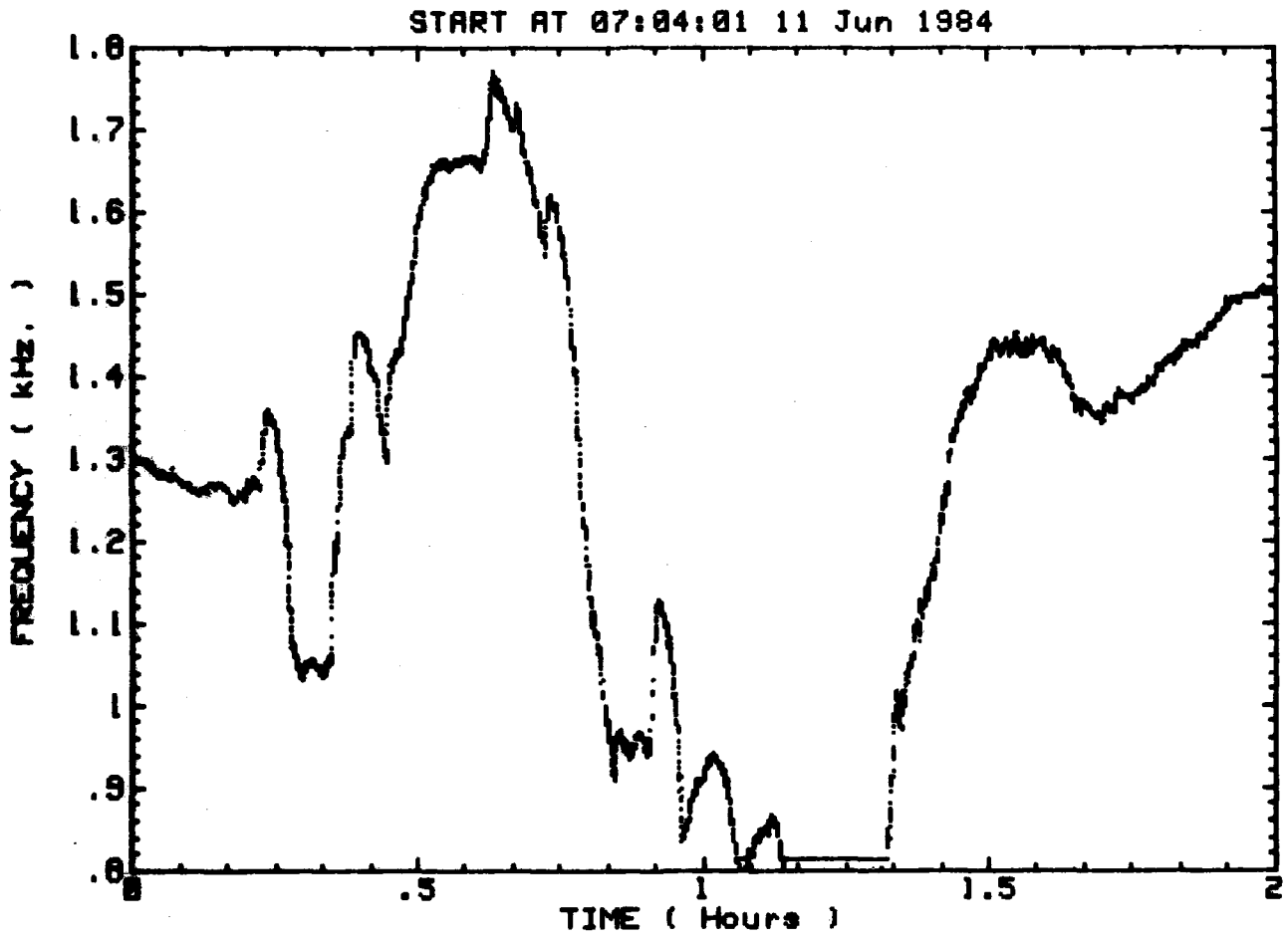


Figure 2. An example of frequency versus time plots, large graph.

and EXECUTE prior to running the program. To get back to the smaller size, type the same thing without the EXPANDED. This option has been programed on key 3. The default is for a small graph. Key 3 alternates between small and large graph.

One thing should be considered when dumping graphics to the printer. It takes about 30 seconds to dump the small graph and about 1 1/2 minutes to dump the large graph. No frequencies are being read during these times. If the time scale on the graph is made short, much data can be missed while the graphs are being dumped. It is recommended that, when dumping graphs to the printer while taking data, the time scale be made quite long, perhaps 4 to 6 hours, to minimize this problem. If greater time resolution is needed it can be obtained by plotting the data from the disk.

SCREEN DISPLAY AND PLOTS

Most of the information displayed on the screen, both for the data acquisition and the disk plots, is fairly self explanatory. The current frequency value is displayed in the upper left corner. To the right of it is shown its number position in the current record. To the right of that is the total number of data samples since recording began. In the upper right, current time is displayed in hours, minutes, and seconds if data are being acquired. If they are being plotted from the disk, it is the time when the measurement was made. In the lower right is displayed the number of the current record, and in the lower left the status of the graphics dump is shown. At the top center of the graph the center frequency is shown. None of these is part of the graph.

The border, scale, and labels of the graph on the screen are plotted in blue. The frequency data are plotted in yellow. If the frequency falls outside the current frequency limits of the graph, the data point is plotted at the limit of the frequency scale in red to indicate that a frequency measurement occurred at this time, but that it was off scale. A replot of the data with a sufficiently large frequency scale would permit these points to be plotted in their correct positions.

As stated earlier, any frequency data that exceed the INTEGER capability of the computer are set to the INTEGER limit before being stored. These values will be plotted at this limit if the frequency scale is large enough. The true frequency values of these points cannot be recovered. These points will, however, give an indication of how much frequency data are falling outside the capabilities of the recording system. If enough data are falling outside the limits and these data are considered to be of interest, it may be advisable to increase the frequency range capabilities of the system even though it will reduce the frequency resolution correspondingly. If most of the data are out of range on one side, it may only be necessary to change the center frequency.

This program has the option of displaying or not displaying the data and graphs. This is accomplished with the use of key 5 and the alpha and graphics keys. If the graph and data are being displayed, push key 5 once and only the graph will display. Push it again and the data display will return. Push the alpha key and the graph will disappear. Push the graphics key and it will

reappear. To completely blank the screen, first push key 5, then the alpha key. To recover the graphics, push the graphics key. To recover the data display, push key 5 again. Key 5 alternates between showing the data display and not showing it.

SECOND PROGRAM

Nearly everything about the first program applies to the second program, listed in Appendix B. However, while the program listed in Appendix A is limited to making frequency measurements, plotting them, and storing them on disk, the second program can be doing other calculations as well. This is because it uses the INTERRUPT capabilities of the system. When the frequency counter has completed a frequency measurement it lets the computer know. The computer accepts the measurement, plots it, and stores it. Between measurements, the computer can be doing other things.

As the program is currently written, the computer sits in an idle loop and displays time and the last frequency measurement, among other things, while waiting for a new measurement. This is redundant information and is used only to show where the computer is between frequency measurements. This idle loop can be replaced with whatever program calculations are of interest.

It should be noted that, even though this program uses an interrupt technique, no data are taken while the program is waiting for input from the keyboard, receiving input from disk, or while outputting to the disk or to the printer. This it has in common with the first program.

Also, this second program has the option of displaying or not displaying data during acquisition. This is accomplished with key 5 and the alpha and graphics keys, as was described for the first program.

SUMMARY

Two programs to acquire frequency data with the use of the HP5345A Frequency Counter have been described. These programs have been written in Basic for the HP9836C computer. The two programs are quite similar, except that the second program uses the interrupt method so that other calculations can be performed between frequency measurements. Both programs read frequency data, plot them on the computer screen, and store them on disk for future processing.

Screen plots of the frequency data can be dumped to the printer, if desired, both when data are being plotted as they are being read and when they are being plotted from the disk. These plots can be either of two sizes.

APPENDIX A

DATA ACQUISITION PROGRAM ONE

```
10    ! ************************************************************
20    ! ************************************************************
30    ! *                                                          *
40    ! *            SIGNAL COLLECTION PROGRAM ONE                 *
50    ! *                                                          *
60    ! * Written by:    R.L. KELLOGG              10 February 1984  *
70    ! *                                                          *
80    ! *                MODIFIED    MRP           19 March 1984     *
90    ! ************************************************************
100   ! ************************************************************
110           !
120           ! SIGNAL COLLECTION is the acquisition program
130           ! for fetching frequency and time data and
140           ! storing it onto a FLOPPY disk.
150           !    Freq data from HP-5345a digital freq counter
160           !    Time data from HP-9836c internal clock
170           !    Stored on left Floppy disk in BDAT format
180           !
190           ! options: (1) screen display and record in real-time
200           !          (2) screen display from Floppy disk record
210           !
220           ! Freq      Frequency data      HP-Freq Counter=702
230           !                               Resolution is .1Hz
240           ! Time      Time data           Time from internal clock
250           !                               Resolution is 1 second
260           !
270           ! Disk      Freq & Time data are transferred to the disk
280           !          in blocks.  It takes about 1 second each 256
290           !          data points for the file transfer.  Expect
300           !          I/O to the disk file with minimum data loss.
310           !
320           !          To maximize the disk storage capacity, both
330           !          Time and Frequency are stored as 2-byte
340           !          integer numbers.  Frequency is scaled to allow
350           !          .1 Hz resolution.  Time storage is more
360           !          problematic.  The julian time of the first data
370           !          word of each 256-block is stored in a separate
380           !          file called "time".  The actual time stored in
390           !          the 256-block is the number of seconds (+one)
400           !          since the filed julian time.  This allows
410           !          any 256-block to range up to 32,766 seconds, or
420           !          about half a day (or about one time/frequency
430           !          intercept every 15 minutes).
440    ! ************************************************************
450   OPTION BASE 1
460   DEG
470   DIM Logo$[30]                          ! Title string
480   DIM Filenme$[30]                       ! File name string
490   INTEGER F_data(1:256)                  ! Frequency data block
500   INTEGER T_data(1:256)                  ! Time data block
510   REAL Colors(15,3)                      ! Color Map
520    ! ************************************************************
530   OUTPUT KBD USING "#,B";255,75          ! Clear screen of alpha
540   CONTROL CRT,5;140                      ! Alpha in blue vice green
550   ASSIGN @Hp_freq TO 712                 ! HP-FREQUENCY COUNTER
560   REMOTE @Hp_freq
570                                          ! Bus  700   (select code)
580                                          ! Add  012   (device address)
590   OUTPUT @Hp_freq;"E8","E:","G0"         ! Enables Remote & Addresses
600                                          ! to Talk.
```

```
610    ! ***************************************************************
620   Sys_disk$=":INTERNAL,4,0"                    ! Right disk for programs
630   Sys_data$=":INTERNAL,4,1"                    ! Left disk for data
640   Filenme$="raw_data"&Sys_data$                ! Raw data file
650   Filetme$="time"&Sys_data$                    ! Start time file
660   Max_rec=250                                  ! Raw data file record length
670                                                ! Disk holds max 270,336 bytes
680         ! IMPORTANT POINT:   >                 ! Utilization as follows:
690         !                    >                 ! 256x(2+2)=1024 bytes/record
700         !     ONE DISK       >                 ! 1024x250 =256,000 bytes/disk
710         !                    >                 !
720         ! 18 HRS COLLECTION  >                 ! If the data rate is one
730         !                    >                 ! measurement per second, then
740         !       TIME         >                 ! 256x250  =64000 time/freq pts
750                                                ! 64000/86400=.74 days=18 hrs
760                                                !
770   X_edge=9                                     ! Clip edge of screen
780   Y_edge=8                                     ! Clip height of screen
790   T_width=5                                    ! Time width default=5 minutes
800   F_width=200                                  ! Freq width default=+/- 200 Hz
810   C_band=100000                                ! Freq center default=100000 Hz
820   L_pos=1                                      ! Logo position default
830   D_resl=10                                    ! 10 gives 1 decimal point
840                                                ! resolution. This allows an
850                                                ! INTEGER range of +/- 3.276 kHz.
860   Flimit=32767
870   Dump$="OFF"                                  ! Default, no graphics dump to
880                                                ! the  printer
890   Plt$="N"                                     ! Default, no plot to HP 7470A
900   DUMP DEVICE IS 701
910   Gsize$="SMALL GRAPH"
920   Dsply$="ON"
930 ! ***************************************************************************
940 ! ***************************************************************************
950 !
960 !                          BEGIN                PROGRAM
970 ! *********
980 Start_screen: !
990   !   INPUT "CENTER FREQUENCY (Hz)",C_band
1000   INPUT "MAX. TIME,(M/H), MIN.,MAX. FREQ. (For plotting)",T_width,Tm$,Fmin,F
max
1010  F_width=(Fmax-Fmin)
1020 ! *********
1030  GOSUB Set_up
1040 ! *********
1050 Begin:!
1060 ! *********
1070  Logo$="DATA ACQUISITION"                     ! Let operator choose option
1080  GOSUB Background
1090  GOSUB Logo
1100  GOSUB Clr_keys
1110  GOSUB Rt0_keys
1120  GOTO Wait_loop
1130 Kys:!////////////////// Key Assignments ////////////////////////////
1140 Rt0_keys:!
1150  ON KEY 0 LABEL "COLLECT DATA" GOTO Real_time
1160  ON KEY 4 LABEL "REVIEW DISK" GOTO Plot_disk
1170  RETURN
1180 Rt1_keys:!
1190  ON KEY 0 LABEL "CONT. PROGRAM" GOTO Rt_1b
1200  ON KEY 4 LABEL "INIT. DISK" GOSUB Rt_1a
```

```
1210  RETURN
1220 Rt2_keys:!
1230  ON KEY 0 LABEL "START COLLECT" GOTO Rt_2a
1240  ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1250  ON KEY 2 LABEL " CHG. SCALE" GOSUB T_scale
1260  ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1270  ON KEY 4 LABEL "STOP COLLECT" GOTO Rt_2b
1280  ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1290  RETURN
1300 Rt3_keys:!
1310  ON KEY 0 LABEL "START PLOT" GOTO Rt_3a
1320  ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1330  ON KEY 2 LABEL "CHG.SCALE" GOSUB T_scale
1340  ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1350  ON KEY 4 LABEL "STOP PLOT" GOTO Rt_3b
1360  ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1370  RETURN
1380 Clr_keys:!
1390  ON KEY 0 LABEL "" GOSUB No_opt
1400  ON KEY 1 LABEL "" GOSUB No_opt
1410  ON KEY 2 LABEL "" GOSUB No_opt
1420  ON KEY 3 LABEL "" GOSUB No_opt
1430  ON KEY 4 LABEL "" GOSUB No_opt
1440  ON KEY 5 LABEL "" GOSUB No_opt
1450  ON KEY 6 LABEL "" GOSUB No_opt
1460  ON KEY 7 LABEL "" GOSUB No_opt
1470  ON KEY 8 LABEL "" GOSUB No_opt
1480  ON KEY 9 LABEL "" GOSUB No_opt
1490  RETURN
1500! ************************************************************************
1510 G_dmp:IF Dump$="OFF" THEN
1520    Dump$="ON"
1530    IF Dsply$="ON" THEN
1540      PRINT TABXY(9,17);"GRAPHICS DUMP IS ON "
1550      PRINT TABXY(30,17);Gsize$
1560    END IF
1570  ELSE
1580    Dump$="OFF"
1590    IF Dsply$="ON" THEN
1600      PRINT TABXY(9,17);"GRAPHICS DUMP IS OFF"
1610      PRINT TABXY(30,17);Gsize$
1620    END IF
1630  END IF
1640  RETURN
1650  !
1660 G_size: !
1670  IF Gsize$="LARGE GRAPH" THEN
1680    DUMP DEVICE IS 701
1690    Gsize$="SMALL GRAPH"
1700    PRINT TABXY(30,17);Gsize$
1710  ELSE
1720    DUMP DEVICE IS 701,EXPANDED
1730    Gsize$="LARGE GRAPH"
1740    PRINT TABXY(30,17);Gsize$
1750  END IF
1760  RETURN
1770 Dsply: !
1780  IF Dsply$="ON" THEN
1790    Dsply$="OFF"
1800    PRINT CHR$(12)
```

```
1810  ELSE
1820    Dsply$="ON"
1830    GOSUB Rerite
1840  END IF
1850  RETURN
1860! *********
1870 Background:!
1880  CLIP OFF
1890! *********
1900  GCLEAR
1910  AREA PEN Grey                                  ! Grey background
1920  OUTPUT KBD USING "#,B";255,75                  ! Erase alphanumeric writing
1930  CLIP ON
1940  RETURN
1950! *********
1960 Logo:!
1970! *********
1980  LORG 4                                         ! Center logo
1990  PEN Yellow                                     ! Always yellow
2000  CSIZE Large                                    ! Always large letters
2010  FOR I=0 TO .1 STEP .04
2020    MOVE L1_pos+I,L_pos
2030    LABEL Logo$                                  ! Bold characters
2040  NEXT I
2050  L_pos=1                                        ! Re-estab logo default position
2060  RETURN
2070! **********
2080 Graf:  !////////////////// Graphics Routine ////////////////////////
2090 Screen_grid:'
2100! **********
2110  IF Plt$<>"Y" THEN GOSUB Background             ! Set up grey background
2120  IF Tm$="M" THEN Tme$=" Minutes "
2130  IF Tm$="H" THEN Tme$=" Hours "
2140  GOSUB Rerite
2150  IF Plt$<>"Y" THEN PEN Ltgrey
2160  IF Plt$="Y" THEN PEN 1
2170  CLIP -X_edge,X_edge,-Y_edge,Y_edge             ! Clip graph area to 9x8
2180  IF Plt$<>"Y" THEN PEN Blue
2190  !
2200  !*****  SCALE TIME AXIS  **********
2210  IF T_width<=10 THEN Xtic=X_edge/(T_width*6)
2220  IF T_width>10 AND T_width<=20 THEN Xtic=X_edge/(T_width*3)
2230  IF T_width>20 THEN Xmaj=2
2240  IF T_width<=20 THEN Xmaj=6
2250  IF T_width>20 THEN Xtic=X_edge/(T_width)
2260  !
2270  !*****  SCALE FREQUENCY AXIS  ******
2280  Ytic=Y_edge/25
2290  Ymaj=5
2300  Ystep=Ytic*Ymaj
2310  Fstep=F_width*Ystep/(2*Y_edge)
2320  !**************************************
2330  IF Plt$<>"Y" THEN PEN Ltgrey
2340  IF Plt$="Y" THEN
2350    INPUT "DO YOU WANT TO DRAW A GRID (Y/N)",Grd$
2360    IF Grd$="Y" THEN
2370      PEN 2
2380  !   GRID Xtic,Ytic
2390    END IF
2400  END IF
```

```
2410 !IF Plt$<>"Y" THEN GRID Xtic,Ytic                    ! Draw black grid
2420  IF Plt$<>"Y" THEN PEN Blue
2430  IF Plt$="Y" THEN PEN 1
2440  AXES Xtic,Ytic,9,8,Xmaj,Ymaj                       ! Draw blue axes
2450  AXES Xtic,Ytic,-9,-8,Xmaj,Ymaj                     ! Draw blue axes
2460  CLIP OFF
2470  !+++++++
2480 Xaxis: !+                                           ! Label Time Axis
2490  !+++++++
2500  IF T_width<6 THEN Tstep=Xtic*Xmaj
2510  IF T_width>=6 THEN Tstep=2*Xtic*Xmaj
2520  FOR I=0 TO 2*(X_edge+.1) STEP Tstep
2530    CSIZE 3
2540    LORG 6
2550    MOVE -X_edge+I,-8.02
2560    T_x=T_width*I/(2*X_edge)
2570    LABEL USING "K";T_x
2580  NEXT I
2590  MOVE 0,-8.6
2600  LABEL USING "K";"TIME (";Tme$;")"
2610  !+++++++++
2620 Yaxis:   !+                                         ! Label Frequency Axis
2630  !+++++++++
2640  F_y=Fmin
2650  FOR J=0 TO 2*Y_edge+.1 STEP Ystep
2660    LORG 8
2670    IF Fmax>=1000 OR Fmin<=(-1000) THEN
2680      Fval=F_y/1000
2690      IF ABS(Fval)<1.E-6 THEN Fval=0
2700    ELSE
2710      Fval=F_y
2720      IF ABS(Fval)<1.E-6 THEN Fval=0
2730    END IF
2740    MOVE -9.1,-Y_edge+J
2750    LABEL USING "K";Fval
2760    F_y=F_y+Fstep
2770  NEXT J
2780  LDIR 90
2790  MOVE -10.47,0
2800  LORG 4
2810  IF Fmax>=1000 OR Fmin<=(-1000) THEN
2820    Fr$="kHz."
2830  ELSE
2840    Fr$="Hz."
2850  END IF
2860  LABEL USING "K";"FREQUENCY ( ";Fr$;" )"
2870  LDIR 0
2880  CLIP ON
2890  RETURN
2900  !
2910 Dd: !////////////////// Data Display Routine ////////////////////////////
2920 ! *********
2930 Display_data: !
2940 ! *********
2950  WHILE Grid>=X_edge                                 ! Check for screen edge
2960    GOSUB Screen_grid
2970    Time_zero=Time                                   ! Set time ordinate
2980    LORG 4
2990    LDIR 0
3000    CSIZE 3
```

```
3010    MOVE 0,8.15
3020    CLIP OFF
3030    PEN Blue
3040    LABEL USING "K";"START AT ";TIME$(Time_zero);" ";DATE$(Time_zero)
3050    CLIP ON
3060    Grid=0
3070  END WHILE
3080  IF Dsply$="ON" THEN
3090    PRINT TABXY(9,5);"                "! CLEAR DATA
3100    PRINT TABXY(9,5);Freq              ! Display FREQ resolution to "D_res1"
3110    PRINT TABXY(21,5);Icount
3120    PRINT TABXY(26,5);Pcount
3130    PRINT TABXY(65,5);TIME$(Time)      ! DisplayHR:MIN:SEC
3140    PRINT TABXY(68,18);Record_nr
3150  ELSE
3160    PRINT CHR$(12)
3170  END IF
3180  Tpos=Time-Time_zero                  ! Scale Time axis
3190  IF Tm$="M" THEN Xpos=Tpos/30*(X_edge/T_width)
3200  IF Tm$="H" THEN Xpos=Tpos/1800*(X_edge/T_width)
3210  Xpos=Xpos-X_edge
3220  Fpos=Freq-Fmin
3230  Ypos=Fpos*2*Y_edge/(Fmax-Fmin)-Y_edge
3240  Grid=Xpos
3250  IF Grid>X_edge AND Dump$="ON" THEN GOSUB Gdump
3260  IF Grid>X_edge THEN Display_data        ! Oops...right edge run off
3270  IF ABS(Fdata)<Flimit THEN
3280    IF Plt$<>"Y" THEN PEN Yellow
3290    IF Plt$="Y" THEN PEN 1
3300    MOVE Xpos,Ypos                       ! Plot data to screen
3310    RPLOT 0,0,-1                         ! PEN UP
3320  END IF
3330  IF Freq>=Fmax OR Fdata>=Flimit THEN
3340    IF Plt$<>"Y" THEN PEN Red
3350    IF Plt$="Y" THEN PEN 2
3360    MOVE Xpos,Y_edge*.97
3370    RPLOT 0,0,-1
3380  END IF
3390  IF Freq<=Fmin OR Fdata<=-Flimit THEN
3400    IF Plt$<>"Y" THEN PEN Red
3410    IF Plt$="Y" THEN PEN 2
3420    MOVE Xpos,-Y_edge*.97
3430    RPLOT 0,0,-1
3440  END IF
3450  RETURN
3460 ! *********
3470 T_scale: ! ///////////////// Change Graphics Scale ////////////////////
3480 ! *********
3490  Logo$="scale time/freq axes"
3500  GOSUB Background
3510  GOSUB Logo
3520  PRINT TABXY(25,15);"Enter Screen Width Time (minutes/hours),(M/H)"
3530  INPUT "Time ",T_width,Tm$
3540  PRINT TABXY(25,16);"Enter Screen Height Fmin., Fmax.  Hz)"
3550  INPUT "Freq ",Fmin,Fmax
3560  F_width=Fmax-Fmin
3570  Logo$="continue"
3580  GOSUB Background
3590  L_pos=-.5
3600  GOSUB Set_up
```

```
3610  GOSUB Graf
3620 !GOSUB Logo
3630  LORG 4
3640  LDIR 0
3650  CSIZE 3
3660  MOVE 0,8.15
3670  CLIP OFF
3680  PEN Blue
3690  LABEL USING "K";"START AT ";TIME$(Time_zero);" ";DATE$(Time_zero)
3700  CLIP ON
3710  RETURN
3720 ! *********
3730 Color_map:!/////////////// Color Map ////////////////////////////////
3740 ! *********
3750  DATA  0,0,0, 1,1,1, .2,.2,.2, 1,0,0, 0,1,0, 0,0,1, 1,1,0
3760  DATA  .1,.1,.1, 0,1,0, 0,0,1,1,1,0, 0,1,0, 0,1,1, 0,0,1, 1,0,1
3770          ! pen 0    black     pen 6  blue       pen 11 yellow
3780          ! pen 1    white     pen 7  yellow     pen 12 green
3790          ! pen 3    grey      pen 8  lt grey    pen 13 cyan
3800          ! pen 4    red       pen 9  green      pen 14 blue
3810          ! pen 5    green     pen 10 blue       pen 15 magenta
3820 ! *********
3830 No_opt:RETURN                                  ! Dummy routine
3840 ! *********
3850 Wait_loop:BEEP 160,.1                          ! Wait Loop
3860 Loop:GOTO Loop
3870 ! ////////////////////Real-time Data Collection//////////////////////
3880 ! *********
3890 Real_time:                                     ! Begin real-time program
3900 ! *********
3910  Logo$="REAL-TIME COLLECTION"                  ! Set up screen
3920  GOSUB Background
3930  GOSUB Logo
3940  GOSUB Clr_keys
3950  GOSUB Rt1_keys
3960  CSIZE Medium
3970  LORG 4
3980  LABEL "*PUT DATA DISK IN LEFT DRIVE"
3990  LABEL "*INITIALIZE DISK IF REQUIRED"
4000  CSIZE Small
4010  PEN Green                                     ! Change Color
4020  LABEL ""
4030  LABEL "(COLLECTION REPLACES PREVIOUS DATA ON THIS DISK, Record by Record)"
4040  GOTO Wait_loop
4050  ! ////////////////////// Initialize Data Disk ////////////////////////
4060 ! *********
4070 Rt_1a:                                         ! Request initialization
4080 ! *********
4090  CSIZE Medium
4100  LORG 4
4110  LABEL ""
4120  LABEL ""
4130  LABEL "INITIALIZATION STARTED"
4140  INITIALIZE Sys_data$                          ! Initialize left data disk
4150  Logo$="continue"
4160  GOSUB Background
4170  GOSUB Logo
4180  BEEP 160,.1
4190  RETURN
4200 ! *********
```

```
4210 Rt_1b:                                    ! Establish data & time file
4220 ! *********
4230  ON ERROR GOTO Rt_1c                      ! If error in file name, create it
4240  CREATE BDAT Filenme$,Max_rec,1024        ! If file exists, don't create
4250  CREATE BDAT Filetme$,Max_rec,10          ! Start time file
4260 Rt_1c:OFF ERROR
4270  ASSIGN @D_write TO Filenme$              ! Open path to data file
4280  ASSIGN @T_write TO Filetme$              ! Open path to start time file
4290  Pcount=1                                 ! Total Nr Points
4300  Logo$="ready to collect"
4310  GOSUB Background
4320  GOSUB Logo
4330  GOSUB Clr_keys
4340  GOSUB Rt2_keys
4350  Record_nr=1                              ! Initialize collect parameters
4360  Icount=1
4370  Grid=X_edge                              ! Used by Display Data
4380  GOSUB Wait_loop                          ! Wait for operator to start
4390 ! *********
4400 Rt_2a:                                    ! Start collection
4410 ! *********
4420 !/////////////////////// Get Data from Freq. Counter ////////////////////
4430 Collect:  !
4440  WHILE Record_nr<=Max_rec                 ! Collect while disk space
4450    WHILE Icount<=256                      ! Collect 256 data points
4460      ENTER @Hp_freq;Frequency             ! Enter data from counter
4470      Time=TIMEDATE                        ! Get time
4480      IF Icount=1 THEN S_time=Time         ! Start time of 256 block
4490      T_data(Icount)=Time-S_time+1         ! Save integer time to seconds
4500      Fdata=INT(D_resl*(Frequency-C_band))
4510      IF Fdata>=Flimit THEN Fdata=Flimit
4520      IF Fdata<=-Flimit THEN Fdata=-Flimit
4530      Freq=Fdata/D_resl
4540      F_data(Icount)=Fdata                 ! Save freq to "D_resl" resolution
4550      GOSUB Display_data                   ! Data to screen
4560      Icount=Icount+1                      ! Up data counter
4570      Pcount=Pcount+1
4580    END WHILE                              ! Datum array now full
4590                                           ! Now have 256 data points...
4600                                           ! Put out to disk
4610    OUTPUT @D_write,Record_nr;T_data(*),F_data(*)
4620    OUTPUT @T_write,Record_nr;S_time
4630    Record_nr=Record_nr+1
4640    Icount=1                               ! Set data counter
4650  END WHILE                                ! Done--filled disk file
4660 ! *********
4670 Rt_2b:                                    ! Terminate collection
4680 ! *********
4690  Logo$="collection terminated"
4700  L_pos=-7                                 ! Position logo at bottom
4710  GOSUB Logo                               ! not to obscure data
4720  IF Record_nr>Max_rec THEN Rt_2c
4730  FOR I=Icount TO 256
4740    T_data(I)=0                            ! Null Time
4750    F_data(I)=0                            ! Null Frequency
4760  NEXT I
4770                                           ! Now have 256 data points
4780                                           ! Final out to disk
4790  OUTPUT @D_write,Record_nr;T_data(*),F_data(*)
4800  OUTPUT @T_write,Record_nr;S_time
```

```
4810 Rt_2c:  !
4820  ASSIGN @D_write TO *                          ! Close Files
4830  ASSIGN @T_write TO *
4840  GOSUB Clr_keys                                ! Loop back to screen options
4850  GOSUB Rt0_keys
4860  GOTO Wait_loop
4870 !
4880 Pd:!////////////////////// Plot Data from Disk ////////////////////////
4890 ! *********
4900 Plot_disk:!
4910 ! *********
4920  INPUT "OUTPUT TO PLOTTER (Y/N)",Plt$
4930  Logo$="PLOT DISK DATA"                        ! time & freq scaling before
4940  GOSUB Clr_keys
4950  IF Plt$="Y" THEN GOSUB Hp_gl
4960  IF Plt$<>"Y" THEN GOSUB Set_up
4970  IF Plt$<>"Y" THEN GOSUB Logo                  ! displaying data from disk
4980  GOSUB Rt3_keys
4990  GOTO Wait_loop
5000 ! ********
5010 Rt_3a:!
5020 ! ********
5030  ASSIGN @D_path TO File$                       ! Open Raw-data File
5040  ASSIGN @T_path TO File$                       ! Open Time file
5050  Pcount=1                                      ! Total # points counter
5060  Grid=X_edge
5070  FOR Record_nr=1 TO Max_rec
5080                                                ! Read block of data from disk
5090    ENTER @D_path,Record_nr;T_data(*),F_data(*)
5100    IF Record_nr=1 THEN
5110      ENTER @T_path,Record_nr;T_first
5120    END IF
5130    ENTER @T_path,Record_nr;S_time
5140    IF T_first>S_time THEN Rt_3b
5150    Icount=1                                      ! Set data in block counter
5160    WHILE Icount<=256
5170      IF T_data(Icount)=0 THEN Rt_3b              ! End if zero (no data)
5180      Time=T_data(Icount)+S_time-1                ! Reconstruct Julian Time
5190      Fdata=F_data(Icount)
5200      Freq=Fdata/D_resl
5210      GOSUB Display_data                          ! Display data to screen
5220      Icount=Icount+1                             ! Up data counter
5230      Pcount=Pcount+1
5240    END WHILE
5250  NEXT Record_nr                                ! Loop until done
5260 ! ************
5270 Rt_3b: !
5280 ! ************
5290  Logo$="plot completed"
5300  L_pos=0                                       ! Put logo at side of screen
5310  L1_pos=10.1
5320  LDIR 90
5330  CLIP OFF
5340  IF Plt$<>"Y" THEN GOSUB Logo                  ! not to obscure data
5350  L1_pos=0
5360  LDIR 0
5370  CLIP ON
5380  ASSIGN @D_path TO *
5390  ASSIGN @T_path TO *                           ! Close files
5400  GOSUB Clr_keys
```

```
5410  GOSUB Rt0_keys
5420  GOTO Wait_loop                              ! Loop back and await operator
5430                                              ! command
5440 Set_up: !/////////////// Initial Setup ////////////////////////////////
5450  GINIT                                       ! Initialize graphics
5460  GCLEAR                                      ! Clear screen of graphics
5470  PLOTTER IS CRT,"INTERNAL";COLOR MAP         ! Use screen as plotter
5480  RESTORE Color_map                           ! Data pointer for read colors
5490  READ Colors(*)                              ! Enter new color map
5500  SET PEN 1 INTENSITY Colors(*)               ! Establish new colors
5510  Large=6                                     ! Large letters
5520  Medium=4                                    ! Medium letters
5530  Small=3                                     ! Small letters
5540  Yellow=7                                    ! Yellow Pen
5550  Ltgrey=8                                    ! Ltgrey Pen
5560  Green=9                                     ! Green  Pen
5570  Blue=13                                     ! Blue   Pen
5580  Grey=3                                      ! Grey Area Pen
5590  Red=4                                       ! Red Pen
5600  GRAPHICS ON
5610  Xrange=100*MAX(1,RATIO)
5620  Yrange=100*MAX(1,1/RATIO)
5630  VIEWPORT .05*Xrange,.95*Xrange,.08*Yrange,.98*Yrange
5640  WINDOW -10.5,10.5,-10,10                    ! Set initial screen window
5650  RETURN
5660                                              !
5670 Hp_gl:PLOTTER IS 705,"HPGL"
5680  RETURN
5690 Gdump:  !/////////////// Dump Graphics to Printer ////////////////////
5700  DUMP GRAPHICS #701
5710  RETURN
5720 Rerite: !
5730  IF Dsply$="ON" THEN
5740    PRINT TABXY(25,1);"Center Frequency is ";C_band/1000;" kHz"
5750    PRINT TABXY(9,4);"FREQUENCY Icount Dcount"! Label screen
5760    PRINT TABXY(67,4);"TIME"
5770    IF Dump$="OFF" THEN
5780      PRINT TABXY(9,17);"GRAPHICS DUMP IS OFF"
5790      PRINT TABXY(30,17);Gsize$
5800    ELSE
5810      PRINT TABXY(9,17);"GRAPHICS DUMP IS ON "
5820      PRINT TABXY(30,17);Gsize$
5830    END IF
5840    PRINT TABXY(67,17);"RECORD"
5850  END IF
5860  RETURN
5870  END
```

APPENDIX B

DATA ACQUISITION PROGRAM TWO

```
10    ! ************************************************************
20    ! ************************************************************
30    ! *                                                          *
40    ! *              SIGNAL COLLECTION PROGRAM TWO               *
50    ! *                                                          *
60    ! * Written by:    R.L. KELLOGG            10 February 1984  *
70    ! *                                                          *
80    ! *                  MODIFIED   MRP          14 March 1984   *
90    ! ************************************************************
100   ! ************************************************************
110           !
120           ! SIGNAL COLLECTION is the acquisition program
130           ! for fetching frequency and time data and
140           ! storing it onto a FLOPPY disk.
150           !    Freq data from HP-5345a digital freq counter
160           !    Time data from HP-9836c internal clock
170           !    Stored on left Floppy disk in BDAT format
180           !
190           ! options: (1) screen display and record in real-time
200           !          (2) screen display from Floppy disk record
210           !
220           ! Freq      Frequency data      HP-Freq Counter-702
230           !                               Resolution is .1Hz
240           ! Time      Time data           Time from internal clock
250           !                               Resolution is 1 second
260           !
270           ! Disk      Freq & Time data are transferred to the disk
280           !          in blocks.  It takes about 1 second each 256
290           !          data points for the file transfer.  Expect
300           !          I/O to the disk file with minimum data loss.
310           !
320           !          To maximize the disk storage capacity, both
330           !          Time and Frequency are stored as 2-byte
340           !          integer numbers.  Frequency is scaled to allow
350           !          .1 Hz resolution.  Time storage is more
360           !          problematic.  The julian time of the first data
370           !          word of each 256-block is stored in a separate
380           !          file called "time".  The actual time stored in
390           !          the 256-block is the number of seconds (+one)
400           !          since the filed julian time.  This allows
410           !          any 256-block to range up to 32,766 seconds, or
420           !          about half a day (or about one time/frequency
430           !          intercept every 15 minutes).
440           !
450           !          Can output graphs to either the printer or
460           !          the HP 7470A Plotter.
470     ! ************************************************************
480   OPTION BASE 1
490   DEG
500   DIM Logo$[30]                           ! Title string
510   DIM Filenme$[30]                        ! File name string
520   INTEGER F_data(1:256)                   ! Frequency data block
530   INTEGER T_data(1:256)                   ! Time data block
540   REAL Colors(15,3)                       ! Color Map
550     ! ************************************************************
560   OUTPUT KBD USING "#,B";255,75           ! Clear screen of alpha
570   CONTROL CRT,5;140                       ! Alpha in blue vice green
580   RESET 7
590   ASSIGN @Hp_freq TO 712                  ! HP-FREQUENCY COUNTER
600   REMOTE @Hp_freq                         ! Bus  700   (select code)
```

```
610   ON INTR 7,14 GOSUB Dread                  ! Add  012   (device address)
620                                             ! Frequency counter works on an
630                                             ! interrupt basis.
640    ! ***************************************************************
650   Sys_disk$=":INTERNAL,4,0"                 ! Right disk for programs
660   Sys_data$=":INTERNAL,4,1"                 ! Left disk for data
670   Filenme$="raw_data"&Sys_data$             ! Raw data file
680   Filetme$="time"&Sys_data$                 ! Start time file
690   Max_rec=250                               ! Raw data file record length
700                                             ! Disk holds max 270,336 bytes
710         ! IMPORTANT POINT:    >             ! Utilization as follows:
720         !                     >             ! 256x(2+2)=1024 bytes/record
730         !     ONE DISK        >             ! 1024x250 =256.000 bytes/disk
740         !                     >             !
750         ! 18 HRS COLLECTION   >             ! If the data rate is one
760         !                     >             ! measurement per second, then
770         !        TIME         >             ! 256x250  =64000 time/freq pts
780                                             ! 64000/86400=.74 days=18 hrs
790                                             !
800   X_edge=9                                  ! Clip edge of screen
810   Y_edge=8                                  ! Clip height of screen
820   T_width=5                                 ! Time width default=5 minutes
830   F_width=200                               ! Freq width default=+/- 200 Hz
840   C_band=100000                             ! Freq center default=100000 Hz
850   L_pos=1                                   ! Logo position default
860   D_res1=10                                 ! 10 gives 1 decimal point
870                                             ! resolution. This allows an
880                                             ! INTEGER range of +/- 3.276 kHz.
890   Flimit=32767                              ! Prevents error stop if freq.
900                                             ! exceeds integer limit.
910   Dump$="OFF"                               ! Default No printer dump of Graph
920   Plt$="N"                                  ! Default No plot to HP 7470A
930   Gsize$="SMALL GRAPH"
940   DUMP DEVICE IS 701
950   Dsply$="ON"
960  ! ***************************************************************************
970  ! ***************************************************************************
980  !
990  !/////////////////////   BEGIN   PROGRAM  ////////////////////////////////
1000 ! *********
1010 Start_screen:!
1020  INPUT "MAX. TIME,(M/H), MIN.,MAX. FREQ. (For plotting)",T_width,Tm$,Fmin,F
max
1030  F_width=(Fmax-Fmin)
1040 ! *********
1050  GOSUB Set_up
1060 ! *********
1070 Begin:!
1080 ! *********
1090  Logo$="DATA ACQUISITION"                  ! Let operator choose option
1100  GOSUB Background
1110  GOSUB Logo
1120  GOSUB Clr_keys
1130  GOSUB Rt0_keys
1140  GOTO Wait_loop
1150 Kys:!//////////////////Key Assignments ////////////////////////////
1160 Rt0_keys:!
1170  ON KEY 0 LABEL "COLLECT DATA" GOTO Real_time
1180  ON KEY 4 LABEL "REVIEW DISK" GOTO Plot_disk
1190  RETURN
1200 Rt1_keys:!
```

```
1210  ON KEY 0 LABEL "CONT. PROGRAM" GOTO Rt_1b
1220  ON KEY 4 LABEL "INIT. DISK" GOSUB Rt_1a
1230  RETURN
1240 Rt2_keys:!
1250  ON KEY 0 LABEL "START COLLECT" GOTO Rt_2a
1260  ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1270  ON KEY 2 LABEL "CHG. SCALE" GOSUB T_scale
1280  ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1290  ON KEY 4 LABEL "STOP COLLECT" GOTO Rt_2b
1300  ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1310  RETURN
1320 Rt3_keys:!
1330  ON KEY 0 LABEL "START PLOT" GOTO Rt_3a
1340  ON KEY 1 LABEL "G_DUMP ON/OFF" GOSUB G_dmp
1350  ON KEY 2 LABEL "CHG. SCALE" GOSUB T_scale
1360  ON KEY 3 LABEL "GRAPH SIZE" GOSUB G_size
1370  ON KEY 4 LABEL "STOP PLOT" GOTO Rt_3b
1380  ON KEY 5 LABEL "DISPLAY OFF/ON" GOSUB Dsply
1390  RETURN
1400 Clr_keys:!
1410  ON KEY 0 LABEL "" GOSUB No_opt
1420  ON KEY 1 LABEL "" GOSUB No_opt
1430  ON KEY 2 LABEL "" GOSUB No_opt
1440  ON KEY 3 LABEL "" GOSUB No_opt
1450  ON KEY 4 LABEL "" GOSUB No_opt
1460  ON KEY 5 LABEL "" GOSUB No_opt
1470  ON KEY 6 LABEL "" GOSUB No_opt
1480  ON KEY 7 LABEL "" GOSUB No_opt
1490  ON KEY 8 LABEL "" GOSUB No_opt
1500  ON KEY 9 LABEL "" GOSUB No_opt
1510  RETURN
1520! ************************************************************************
1530 G_dmp:IF Dump$="ON" THEN
1540    IF Dsply$="ON" THEN PRINT TABXY(9,17);"GRAPHICS DUMP IS OFF"
1550    Dump$="OFF"
1560    IF Dsply$="ON" THEN PRINT TABXY(30,17);Gsize$
1570  ELSE
1580    IF Dsply$="ON" THEN PRINT TABXY(9,17);"GRAPHICS DUMP IS ON "
1590    Dump$="ON"
1600    IF Dsply$="ON" THEN PRINT TABXY(30,17);Gsize$
1610  END IF
1620  RETURN
1630  !
1640 G_size:   !
1650  IF Gsize$="LARGE GRAPH" THEN
1660    DUMP DEVICE IS 701
1670    Gsize$="SMALL GRAPH"
1680    IF Dsply$="ON" THEN PRINT TABXY(30,17);Gsize$
1690  ELSE
1700    DUMP DEVICE IS 701,EXPANDED
1710    Gsize$="LARGE GRAPH"
1720    IF Dsply$="ON" THEN PRINT TABXY(30,17);Gsize$
1730  END IF
1740  RETURN
1750 Dsply:  !
1760  IF Dsply$="ON" THEN
1770    Dsply$="OFF"
1780    PRINT CHR$(12)
1790  ELSE
1800    Dsply$="ON"
```

```
1810    GOSUB Rerite
1820  END IF
1830  RETURN
1840! *********
1850 Background:!
1860  CLIP OFF
1870! *********
1880  GCLEAR
1890  AREA PEN Grey                                  ! Grey background
1900  OUTPUT KBD USING "#,B":255,75                  ! Erase alphanumeric writing
1910  MOVE -10.5,-10
1920  CLIP ON
1930  RETURN
1940! *********
1950 Logo:!
1960! *********
1970  LORG 4                                         ! Center logo
1980  PEN Yellow                                     ! Always yellow
1990  CSIZE Large                                    ! Always large letters
2000  FOR I=0 TO .1 STEP .04
2010    MOVE L!_pos+I,L_pos
2020    LABEL Logo$                                  ! Bold characters
2030  NEXT I
2040  L_pos=!                                        ! Re-estab logo default position
2050  RETURN
2060! **********
2070 Graf:!////////////////// Graphics Routine //////////////////////////
2080 Screen_grid:!
2090! **********
2100  IF Plt$<>"Y" THEN GOSUB Background      ! Set up grey background
2110  IF Tm$="M" THEN Tme$=" Minutes "
2120  IF Tm$="H" THEN Tme$=" Hours "
2130  IF Dsply$="ON" THEN GOSUB Rerite
2140  IF Plt$<>"Y" THEN PEN Ltgrey
2150  IF Plt$="Y" THEN PEN 1
2160  CLIP -X_edge,X_edge,-Y_edge,Y_edge       ! Clip graph area to 9x8
2170  IF Plt$<>"Y" THEN PEN Blue
2180  !
2190  !*****  SCALE TIME AXIS  **********
2200  IF T_width<=10 THEN Xtic=X_edge/(T_width=6)
2210  IF T_width>10 AND T_width<=20 THEN Xtic=X_edge/(T_width=3)
2220  IF T_width>20 THEN Xmaj=2
2230  IF T_width<=20 THEN Xmaj=6
2240  IF T_width>20 THEN Xtic=X_edge/(T_width)
2250  !
2260  !*****  SCALE FREQUENCY AXIS  ******
2270  Ytic=Y_edge/25
2280  Ymaj=5
2290  Ystep=Ytic=Ymaj
2300  Fstep=F_width=Ystep/(2=Y_edge)
2310  !**************************************
2320  IF Plt$="Y" THEN
2330    INPUT "DO YOU WANT TO DRAW A GRID (Y/N)",Grd$
2340    IF Grd$="Y" THEN
2350      PEN 2
2360      GRID Xtic,Ytic                                  ! Draw Grid
2370    END IF
2380  END IF
2390  IF Plt$<>"Y" THEN PEN Blue
2400  IF Plt$="Y" THEN PEN 1
```

```
2410  AXES Xtic,Ytic,9,8,Xmaj,Ymaj                    ! Draw blue axes
2420  AXES Xtic,Ytic,-9,-8,Xmaj,Ymaj                  ! Draw blue axes
2430  CLIP OFF
2440  !+++++++
2450 Xaxis: !+                                        ! Label Time Axis
2460  !+++++++
2470  PEN Blue
2480  IF T_width<6 THEN Tstep=Xtic*Xmaj
2490  IF T_width>=6 THEN Tstep=2*Xtic*Xmaj
2500  FOR I=0 TO 2*(X_edge+.1) STEP Tstep
2510    CSIZE 3
2520    LORG 6
2530    MOVE -X_edge+I,-8.02
2540    T_x=T_width*I/(2*X_edge)
2550    LABEL USING "K":T_x
2560  NEXT I
2570  MOVE 0,-8.6
2580  LABEL USING "K";"TIME (";Tme$;")"
2590  !+++++++++
2600 Yaxis:   !+                                      ! Label Frequency Axis
2610  !+++++++++
2620  PEN Blue
2630  F_y=Fmin
2640  FOR J=0 TO 2*Y_edge+.1 STEP Ystep
2650    LORG 8
2660    IF Fmax>=1000 OR Fmin<=(-1000) THEN
2670      Fval=F_y/1000
2680      IF ABS(Fval)<1.E-6 THEN Fval=0
2690    ELSE
2700      Fval=F_y
2710      IF ABS(Fval)<1.E-6 THEN Fval=0
2720    END IF
2730    MOVE -9.1,-Y_edge+J
2740    LABEL USING "K":Fval
2750    F_y=F_y+Fstep
2760  NEXT J
2770  LDIR 90
2780  MOVE -10.47,0
2790  LORG 4
2800  IF Fmax>=1000 OR Fmin<=(-1000) THEN
2810    Fr$="kHz."
2820  ELSE
2830    Fr$="Hz."
2840  END IF
2850  LABEL USING "K";"FREQUENCY ( ";Fr$;" )"
2860  LDIR 0
2870  CLIP ON
2880  RETURN
2890 Dd:  !////////////////////// Display Data ////////////////////////////////
2900  ! *********
2910 Display_data: !
2920  ! *********
2930  WHILE Grid>=X_edge                              ! Check for screen edge
2940    GOSUB Screen_grid
2950    Time_zero=Time                                ! Set time ordinate
2960    CLIP OFF
2970    PEN Blue
2980    LORG 4
2990    MOVE 0,8.15
3000    LABEL USING "K";"START AT ";TIME$(Time_zero);" ";DATE$(Time_zero)
```

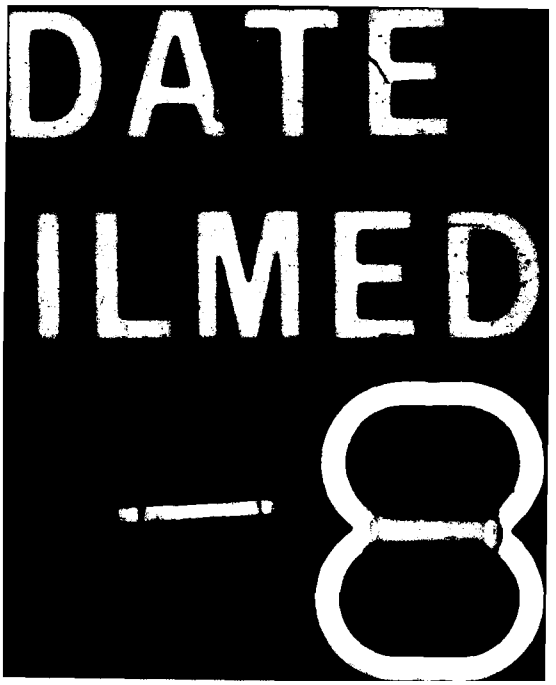
```
3010    CLIP ON
3020    Grid=0
3030  END WHILE
3040  IF Dsply$="ON" THEN PRINT TABXY(9,5);"                    "  ! CLEAR DATA
3050  IF Dsply$="ON" THEN PRINT TABXY(9,5);Freq          ! Display FREQ resolution
3060                                                     ! to 'D_resl'
3070  IF Dsply$="ON" THEN PRINT TABXY(21,5);Icount
3080  IF Dsply$="ON" THEN PRINT TABXY(26,5);Pcount
3090  IF Dsply$="ON" THEN PRINT TABXY(65,5);TIME$(Time) ! Display HR:MIN:SEC
3100  IF Dsply$="ON" THEN PRINT TABXY(68,18);Record_nr
3110  Tpos=Time-Time_zero                                ! Scale Time axis
3120  IF Tm$="M" THEN Xpos=Tpos/30*(X_edge/T_width)
3130  IF Tm$="H" THEN Xpos=Tpos/1800*(X_edge/T_width)
3140  Xpos=Xpos-X_edge
3150  Fpos=Freq-Fmin
3160  Ypos=Fpos*2*Y_edge/(Fmax-Fmin)-Y_edge
3170  Grid=Xpos
3180  IF Grid>X_edge AND Dump$="ON" THEN GOSUB Gdump   ! Output plot to printer
3190  IF Grid>X_edge THEN Display_data              ! Oops...right edge run off
3200  IF ABS(Fdata)<Flimit THEN
3210    IF Plt$<>"Y" THEN PEN Yellow
3220    IF Plt$="Y" THEN PEN 1
3230    MOVE Xpos,Ypos                             ! Plot data to screen
3240    RPLOT 0,0,-1                               ! PEN UP
3250  END IF
3260  IF Freq>=Fmax OR Fdata>=Flimit THEN
3270    IF Plt$<>"Y" THEN PEN Red
3280    IF Plt$="Y" THEN PEN 2
3290    MOVE Xpos,Y_edge*.97
3300    RPLOT 0,0,-1
3310  END IF
3320  IF Freq<=Fmin OR Fdata<=-Flimit THEN
3330    IF Plt$<>"Y" THEN PEN Red
3340    IF Plt$="Y" THEN PEN 2
3350    MOVE Xpos,-Y_edge*.97
3360    RPLOT 0,0,-1
3370  END IF
3380  RETURN
3390  !////////////////// Change Graph Scale ////////////////////////////
3400 ! *********
3410 T_scale: !                                  ! Change screen scale factors
3420 ! *********                                   for graphics.
3430  DISABLE INTR 7
3440  Logo$="scale time/freq axes"
3450  GOSUB Background
3460  GOSUB Logo
3470  PRINT TABXY(25,15);"Enter Screen Width Time (minutes/hours).(M/H)"
3480  INPUT "Time ",T_width,Tm$
3490  PRINT TABXY(25,16);"Enter Screen Height Fmin., Fmax.  Hz)"
3500  INPUT "Freq ",Fmin,Fmax
3510  F_width=Fmax-Fmin
3520  Logo$="continue"
3530  GOSUB Background
3540  L_pos=-.5
3550  GOSUB Set_up
3560  PEN Blue
3570  GOSUB Graf
3580  CLIP OFF
3590  LORG 4
3600  MOVE 0,8.15
```

```
3610  LABEL USING "K":"START AT ";TIME$(Time_zero);" ";DATE$(Time_zero)
3620  CLIP ON
3630  ENABLE INTR 7
3640  RETURN
3650  !////////////////////////// Color Map ////////////////////////////////
3660 ! *********
3670 Color_map:!
3680 ! *********
3690  DATA  0,0,0, 1,1,1, .2,.2,.2, 1,0,0, 0,1,0, 0,0,1, 1,1,0
3700  DATA  .1,.1,.1, 0,1,0, 0,0,1,1,1,0, 0,1,0, 0,1,1, 0,0,1, 1,0,1
3710          ! pen 0    black     pen 6  blue       pen 11 yellow
3720          ! pen 1    white     pen 7  yellow     pen 12 green
3730          ! pen 3    grey      pen 8  lt grey    pen 13 cyan
3740          ! pen 4    red       pen 9  green      pen 14 blue
3750          ! pen 5    green     pen 10 blue       pen 15 magenta
3760 ! *********
3770 No_opt:RETURN                                  ! Dummy routine
3780 ! *********
3790 Wait_loop:BEEP 160,.05                         ! Wait Loop
3800 Loop:DISABLE INTR 7
3810  GOTO Loop
3820 ! *********
3830 Real_time: !////////////// Begin real-time program ///////////////////
3840 ! *********
3850  Logo$="REAL-TIME COLLECTION"                  ! Set up screen
3860  GOSUB Background
3870  GOSUB Logo
3880  GOSUB Clr_keys
3890  GOSUB Rt1_keys
3900  CSIZE Medium
3910  LORG 4
3920  LABEL "*PUT DATA DISK IN LEFT DRIVE"
3930  LABEL "*INITIALIZE DISK IF REQUIRED"
3940  CSIZE Small
3950  PEN Green                                     ! Change Color
3960  LABEL ""
3970  LABEL "(COLLECTION replaces previous DATA on this DISK: Record by Record)"
3980  GOTO Wait_loop
3990  !////////////////// Initialize Data Disk ////////////////////////////
4000 ! *********
4010 Rt_1a:                                         ! Request initialization
4020 ! *********
4030  CSIZE Medium
4040  LORG 4
4050  LABEL ""
4060  LABEL ""
4070  LABEL "INITIALIZATION STARTED"
4080  INITIALIZE Sys_data$                          ! Initialize left data disk
4090  Logo$="continue"
4100  GOSUB Background
4110  GOSUB Logo
4120  BEEP 160,.05
4130  RETURN
4140 ! *********
4150 Rt_1b:                                         ! Establish data & time file
4160 ! *********
4170  ON ERROR GOTO Rt_1c                           ! If error in file name, create it
4180  CREATE BDAT File_me$,Max_rec,1024             ! If file exists, don't create
4190  CREATE BDAT File_tme$,Max_rec,10              ! Start time file
4200 Rt_1c:OFF ERROR
```

```
4210  ASSIGN @D_write TO Filenme$                ! Open path to data file
4220  ASSIGN @T_write TO Filetme$                ! Open path to start time file
4230  Pcount=0                                   ! Total Nr Points
4240  Logo$="ready to collect"
4250  GOSUB Background
4260  GOSUB Logo
4270  GOSUB Clr_keys
4280  GOSUB Rt2_keys
4290  Record_nr=1                                ! Initialize collect parameters
4300  Icount=0
4310  Grid=X_edge                                ! Used by Display Data
4320  GOSUB Wait_loop                            ! Wait for operator to start
4330 ! *********
4340 Rt_2a:                                      ! Start collection
4350 ! *********
4360 Collect:  !
4370  OUTPUT @Hp_freq;"E8","E:","G0" ! Remote Enable & Addresses Counter to talk
4380  ENABLE INTR 7;2
4390 Idler:  !////////// Waiting for Frequency Counter Interrupt ////////////
4400         !
4410  IF Dsply$="ON" THEN
4420    DISP USING Fmta;DATE$(TIMEDATE)," ",TIME$(TIMEDATE),Freq,Icount,Pcount,R
ecord_nr
4430  ELSE
4440    DISP ""
4450  END IF
4460  GOTO Idler
4470 Fmta:IMAGE 7X,K,K,K,X,MDDDD,D,3X,DDD,3X,DDDDD,3X,DDD
4480  !
4490  !///////////////// Terminate Data Collection ////////////////////////////
4500 ! *********
4510 Rt_2b: !
4520 ! *********
4530  Logo$="collection terminated"
4540  L_pos=-7                                   ! Position logo at bottom
4550  GOSUB Logo                                 ! not to obscure data
4560  IF Record_nr>Max_rec THEN Rt_2c
4570  FOR I=Icount TO 256
4580    T_data(I)=0                              ! Null Time
4590    F_data(I)=0                              ! Null Frequency
4600  NEXT I
4610                                             ! Now have 256 data points
4620                                             ! Final out to disk
4630  OUTPUT @D_write,Record_nr;T_data(*),F_data(*)
4640  OUTPUT @T_write,Record_nr;S_time
4650 Rt_2c:  !
4660  ASSIGN @D_write TO *                       ! Close Files
4670  ASSIGN @T_write TO *
4680  GOSUB Clr_keys                             ! Loop back to screen options
4690  GOSUB Rt0_keys
4700  GOTO Wait_loop
4710 Pd:!////////////////////// Plot disk data ////////////////////////////////
4720 ! *********
4730 Plot_disk:!
4740 ! *********
4750  INPUT "OUTPUT TO PLOTTER (Y/N)",Plt$       ! Plot on 7470A Plotter?
4760  Logo$="PLOT DISK DATA"                     ! time&freq scaling before
4770  GOSUB Clr_keys
4780  IF Plt$="Y" THEN GOSUB Hp_gl
4790  IF Plt$<>"Y" THEN GOSUB Set_up
4800  IF Plt$<>"Y" THEN GOSUB Logo               ! displaying data from disk
```

```
4810  GOSUB Rt3_keys
4820  GOTO Wait_loop
4830 ! ********
4840 Rt_3a:!
4850 ! ********
4860  ASSIGN @D_path TO Filenme$                ! Open Raw-data File
4870  ASSIGN @T_path TO Filetme$                ! Open Time file
4880  Pcount=0                                  ! Total # points counter
4890  Grid=X_edge
4900  FOR Record_nr=1 TO Max_rec
4910                                            ! Read block of data from disk
4920    ENTER @D_path,Record_nr;T_data(*),F_data(*)
4930    IF Record_nr=1 THEN
4940      ENTER @T_path,Record_nr;T_first
4950    END IF
4960    ENTER @T_path,Record_nr;S_time
4970    IF T_first>S_time THEN Rt_3b
4980    Icount=0                                ! Set data in block counter
4990    WHILE Icount<256
5000      Icount=Icount+1                       ! Up data counter
5010      Pcount=Pcount+1
5020      IF T_data(Icount)=0 THEN Rt_3b        ! End if zero (no data)
5030      Time=T_data(Icount)+S_time-1          ! Reconstruct Julian Time
5040      Fdata=F_data(Icount)
5050      Freq=Fdata/D_resl
5060      GOSUB Display_data                    ! Display data to screen
5070    END WHILE
5080  NEXT Record_nr                            ! Loop until done
5090 ! ************
5100 Rt_3b: !
5110 ! ************
5120  Logo$="plot completed"
5130  L_pos=0                                   ! Put logo at side of screen
5140  L1_pos=10.1                               ! so as not to obscure data
5150  LDIR 90
5160  CLIP OFF
5170  IF Plt$<>"Y" THEN GOSUB Logo
5180  L1_pos=0
5190  LDIR 0
5200  CLIP ON
5210  ASSIGN @D_path TO *
5220  ASSIGN @T_path TO *                       ! Close files
5230  GOSUB Clr_keys
5240  GOSUB Rt0_keys
5250  GOTO Wait_loop                            ! Loop back and await operator
5260                                            ! command
5270 Set_up: !/////////////// Initial Setup ////////////////////////////////
5280  GINIT                                     ! Initialize graphics
5290  GCLEAR                                    ! Clear screen of graphics
5300  PLOTTER IS CRT,"INTERNAL";COLOR MAP       ! Use screen as plotter
5310  RESTORE Color_map                         ! Data pointer for read colors
5320  READ Colors(*)                            ! Enter new color map
5330  SET PEN 1 INTENSITY Colors(*)             ! Establish new colors
5340  Large=6                                   ! Large letters
5350  Medium=4                                  ! Medium letters
5360  Small=3                                   ! Small letters
5370  Yellow=7                                  ! Yellow Pen
5380  Ltgrey=8                                  ! Ltgrey Pen
5390  Green=9                                   ! Green  Pen
5400  Blue=13                                   ! Blue   Pen
```

```
5410  Grey=3                                        ! Grey Area Pen
5420  Red=4                                         ! Red Pen
5430  GRAPHICS ON
5440  Xrange=100*MAX(1,RATIO)
5450  Yrange=100*MAX(1,1/RATIO)
5460  VIEWPORT .05*Xrange,.95*Xrange,.08*Yrange,.98*Yrange
5470  WINDOW -10.5,10.5,-10,10                      ! Set initial screen window
5480  RETURN
5490  ! ///////////////// Assign Graphics to HP 7470A Plotter ///////////////
5500 Hp_gl:PLOTTER IS 705,"HPGL"
5510  RETURN
5520 Dread:  !/////////////// Read frequency counter ////////////////////////
5530  Icount=Icount+1
5540  Pcount=Pcount+1
5550  ENTER @Hp_freq;Frequency                      ! Enter data from counter
5560  Time=TIMEDATE                                 ! Get time
5570  IF Icount=1 THEN S_time=Time                  ! Start time of 256 block
5580  T_data(Icount)=Time-S_time+1                  ! Save integer time to seconds
5590  Fdata=INT(D_resl*(Frequency-C_band))
5600  IF Fdata>=Flimit THEN Fdata=Flimit
5610  IF Fdata<=-Flimit THEN Fdata=-Flimit
5620  Freq=Fdata/D_resl
5630  F_data(Icount)=Fdata                          ! Save freq to "D_resl" resolution
5640  GOSUB Display_data                            ! Data to screen
5650  IF Icount>=256 THEN GOSUB Dstore              ! Up data counter
5660  ENABLE INTR 7
5670  TRIGGER @Hp_freq
5680  RETURN
5690                                                ! Now have 256 data points...
5700                                                ! Put out to disk
5710 Dstore: !/////////////// Output Data to Disk ////////////////////////////
5720         !
5730  OUTPUT @D_write,Record_nr;T_data(*),F_data(*)
5740  OUTPUT @T_write,Record_nr;S_time
5750  Record_nr=Record_nr+1
5760  Icount=0                                      ! Set data counter
5770  IF Record_nr>Max_rec THEN STOP                ! Done--filled disk file
5780  RETURN
5790  !
5800 Gdump:!///////////////// Output graph to printer ////////////////////
5810  DUMP GRAPHICS #701 ! For double size plots EXECUTE 'DUMP DEVICE IS #701,EX
PANDED'  once. before running the program.
5820  RETURN
5830 Rerite:   !
5840  PRINT TABXY(25,1);"Center Frequency is ";C_band/1000;" kHz"
5850  PRINT TABXY(9,4);"FREQUENCY Icount Dcount"  ! Label screen and
5860  PRINT TABXY(67,4);"TIME"                    ! Create black grid with
5870  PRINT TABXY(67,17);"RECORD"                 ! blue axes
5880  PRINT TABXY(9,17);"GRAPHICS DUMP IS ON "
5890  IF Dump$<>"ON" THEN PRINT TABXY(9,17);"GRAPHICS DUMP IS OFF"
5900  IF Gsize$="SMALL GRAPH" THEN PRINT TABXY(30,17);"SMALL GRAPH"
5910  IF Gsize$="LARGE GRAPH" THEN PRINT TABXY(30,17);"LARGE GRAPH"
5920  RETURN
5930  END
```


DATE
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